



**BBC**

*T. SOMERVILLE*

ENGINEERING DIVISION  
**MONOGRAPH**  
BRITISH BROADCASTING CORPORATION

No. 10

AN AUTOMATIC SYSTEM FOR SYN-  
CHRONIZING SOUND ON QUARTER-  
INCH MAGNETIC TAPE WITH ACTION  
ON 35-MM CINEMATOGRAPH FILM

by L. H. GRIFFITHS, M.A., B.Sc., A.M.I.E.E.,  
N. W. WOODWARD, B.Sc.(Eng.), Grad.I.E.E.



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(PLANNING AND INSTALLATION DEPARTMENT, BBC ENGINEERING DIVISION)

JANUARY 1957

BRITISH BROADCASTING CORPORATION

## FOREWORD

**T**HIS is one of a series of Engineering Monographs published by the British Broadcasting Corporation. About six are produced every year, each dealing with a technical subject within the field of television and sound broadcasting. Each Monograph describes work that has been done by the Engineering Division of the BBC and includes, where appropriate, a survey of earlier work on the same subject. From time to time the series may include selected reprints of articles by BBC authors that have appeared in technical journals. Papers dealing with general engineering developments in broadcasting may also be included occasionally.

This series should be of interest and value to engineers engaged in the fields of broadcasting and of telecommunications generally.

Individual copies cost 5s. post free, while the annual subscription is £1 post free. Orders can be placed with newsagents and booksellers, or BBC PUBLICATIONS, 35 MARYLEBONE HIGH STREET, LONDON, W.1.

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8.	<i>An Automatic Integrator for Determining the Mean Spherical Response of Loudspeakers and Microphones</i>	AUGUST 1956
9.	<i>The Application of Phase-coherent Detection and Correlation Methods to Room Acoustics</i>	NOVEMBER 1956

# AN AUTOMATIC SYSTEM FOR SYNCHRONIZING SOUND ON QUARTER-INCH MAGNETIC TAPE WITH ACTION ON 35-MM CINEMATOGRAPH FILM

## SUMMARY

It is frequently desirable in a television service to be able to store unmarried cinematograph film together with the sound recording associated with it. As many of the sound recordings may originally have been made on 35-mm sprocketed magnetic film the practice could become uneconomic both from the point of view of the space necessary for storage and also from that of the amount of sprocketed magnetic film which might be tied up for indefinite periods. The search for a practical alternative has resulted in the development of an automatic system for synchronizing sound recorded on standard  $\frac{1}{4}$  in. magnetic tape with sprocketed sound or picture film. A prototype equipment has been constructed and installed in the Film Dubbing Suite at the BBC's Television Studios at Lime Grove, London.

Part I of this Monograph outlines the programme requirements which led to the development of the system and the methods by which synchronization is achieved, whilst a detailed description and information on the performance of the equipment itself are given in Part II.

## PART I. GENERAL REQUIREMENTS OF THE SYSTEM

### 1. Introduction

The synchronizing system described in this Monograph was produced to meet a programme requirement for the economical storage of television film sound which had originally been recorded and transmitted using 35-mm sprocketed magnetic film. Storage of the magnetic film itself, or a photographic copy, is expensive, makes heavy demands on valuable storage space and necessitates much larger stocks of material being held to meet the requirements of the service.

Unperforated  $\frac{1}{4}$  in. magnetic recording tape on the other hand presents an economical method of storage and, provided that it could be replayed without loss of synchronism with the picture film, would, it was felt, meet the demands of the programme departments.

A series of tests was accordingly carried out to determine the extent to which loss of synchronism occurred when the sound for a ten-minute reel of film was recorded and replayed on a standard high-grade tape recorder driven by a synchronous motor.

It was found that although the tape was recorded and replayed on the same machine the loss of synchronism over a period of a few minutes made the system virtually unusable. Consideration was therefore given to devising a system which would correct, if possible automatically, for this loss of synchronism as it occurred.

### 2. The Requirements for a Synchronizing System

No synchronizing difficulties arise when standard film cameras, projectors, and recording machines are run together on a common mains supply, since they are fitted with synchronous motors which drive the film through gears and sprockets. With the BBC repetition rate of 25 frames per second, one film frame always passes through each machine in the time occupied by two cycles of the mains supply.

When a tape recorder is used in conjunction with film machines on the same supply, the condition for maintaining synchronism between the tape and film is that if a given length of tape passes through the recorder in one frame period during recording, then the same length should pass through in one frame period during replay. Since one frame period is equal to two mains periods, the simplest method of checking for slippage is to record the mains frequency on the tape as a reference signal and to check during replay that the frequency of this reference signal is exactly equal to the mains frequency. If this condition is fulfilled no overall slippage has occurred. This criterion remains valid even if the mains frequency is different during recording and replay.

On the other hand if slippage does take place, as it invariably does owing to imperfect drive and wear and thermal expansion of the capstan, a phase drift occurs between the reference signal and the mains supply.

If some method is provided whereby the running speed of the tape recorder motor may be advanced or retarded to correct this phase drift, the requirements for a synchronizing system have been fulfilled.

### 3. Preliminary Work

The only suitable tape recorder which could be made available for the experimental work was a type BTR/1B manufactured by Electric and Musical Industries Ltd. This machine was modified so that a 50 c/s reference signal could be combined with the recorded programme sound. The reference signal was derived from the a.c. supply to the recorder motor and fed into the system at 20 dB below peak modulation level.

On replay the programme was passed through an 80 c/s high-pass filter, which removed the reference signal, and rerecorded on 35-mm magnetic film for subsequent review or transmission.

The correction for tape slippage was made by varying

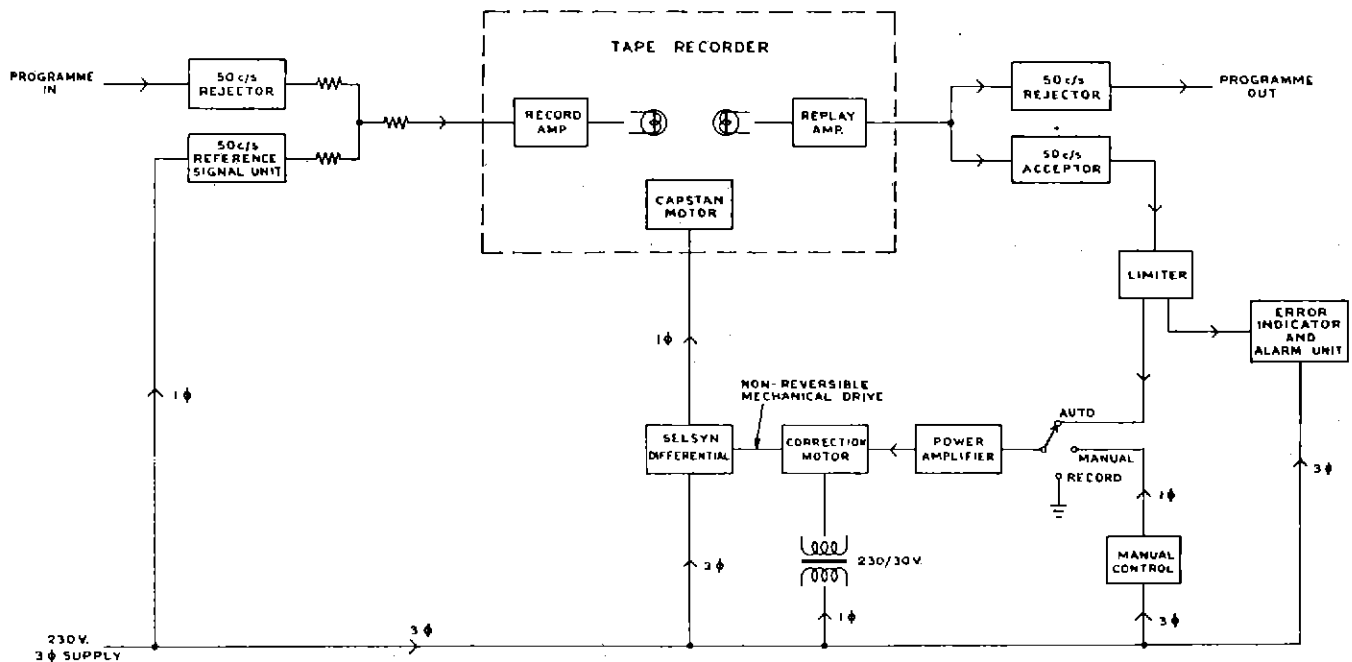


Fig. 1 — Block schematic diagram of the equipment

the speed of the tape recorder manually during replay so that the reference signal and the mains supply showed no relative phase drift when observed on a double beam oscilloscope. In this way full synchronization was achieved and the immediate requirements were satisfied although the necessity for manual operation made the system somewhat clumsy.

Work was therefore begun on the fully automatic synchronizing system which forms the subject of this Monograph.

#### 4. The Automatic Synchronizing System

The complete installation consists of the BRT/1B recorder operating with a tape speed of 15 in./sec. and a 4 ft steel cabinet which houses the synchronizing equipment.

The method of operation is shown in Fig. 1.

##### 4.1 Recording Procedure

During recording the programme is combined with a 50 c/s reference signal derived from the common 230V three-phase mains supply used to drive both the 35-mm magnetic recorder/reproducer and the tape recorder. The reference signal is filtered in order to remove any harmonics which may be present in the mains supply and fed into the system at 20 dB below peak modulation level. To avoid possible interference with the synchronizing system any 50 c/s components occurring in the programme waveform are removed by a rejector circuit.

The tape recorder capstan motor runs synchronously from the mains supply during recording, the selsyn differential being effectively locked in this condition.

##### 4.2 Replay Procedure

During replay the programme is passed through a 50 c/s rejector circuit which removes the reference signal and is then rerecorded on 35-mm magnetic film for review or transmission. The reference signal passes through the 50 c/s acceptor circuit to a limiter whose output voltage and waveform remain substantially constant over a wide range of input levels.

For automatic control the output of the limiter is fed to a 30-watt power amplifier which provides the driving power for the armature windings of the correction motor. The motor field is energized with 30V single-phase derived from the three-phase mains supply.

The purpose of the correction motor is to compare the phase of the amplified reference signal with the mains supply and to advance or retard the capstan motor, as necessary, to maintain a constant phase difference between the two.

It is shown in Part II, Section 10, that when there is a phase difference of  $90^\circ$  between the armature and field currents the motor will remain stationary, but that if the phase drifts to either side of this position the motor will rotate in the direction required to restore the  $90^\circ$  phase difference.

In this way it replaces the double beam oscilloscope used for phase comparison in the original manually controlled system and at the same time automatically applies the necessary correction. The correction motor is mechanically coupled through a 50:1 non-reversible reduction drive to the selsyn differential. This is a standard type of selsyn motor but in the present application it is used as a continuously variable phase shifting transformer. 230V

three-phase is applied to the stator and 230V single-phase is taken from the rotor, the phase of this output being varied as required by the rotation of the motor shaft.

The effect of varying the phase is to advance or retard the synchronous capstan motor. In this way the drive from the correction motor is transmitted to the tape and synchronism maintained.

#### 4.3 Error Indication

To facilitate operation a tape error indicator is provided, together with an alarm circuit which sounds a buzzer if the tape error approaches the maximum which the system is designed to correct.

The error indicator consists of a receiver magstrip which has 50V three-phase derived from the mains supply applied to its stator and the limiter output applied to its rotor. The magstrip pointer gives a direct indication of the relative phase of the limiter output. The phase corresponding to zero tape error is that which produces the 90° equilibrium position of the corrector motor and it is represented by a fixed point on the indicator scale. The indicator provides a sensitive indication of tape error, one revolution

being equivalent to a loss of synchronism of 0.5 frame.

In the alarm circuit the limiter output corresponding to zero tape error is balanced by a signal of equal amplitude and opposite phase derived from the rotor winding of a transmitter magstrip whose stator is supplied with 50V three-phase from the mains supply.

If a significant tape error occurs the phase of the limiter output changes and upsets the balance condition. The resulting signal is amplified and made to operate a relay which sounds the alarm buzzer.

#### 4.4 Manual Control Facilities

Provision is made for switching the input of the power amplifier from the limiter output to the rotor winding of a transmitter magstrip. This magstrip is identical to that used in the alarm circuit and its rotor winding supplies a 50 c/s output of any desired phase.

It can therefore be used, if required, for manual control of the recorder. Its main function, however, is to test the operation of the power amplifier and correction motor, since it provides an immediate method of simulating a tape error of any magnitude.

## PART II. THE EQUIPMENT

### 5. Introduction

The synchronizing equipment is housed in a steel cabinet 4 ft high, by 2 ft wide, by 2 ft deep and incorporates the following units:

- Filter Panel
- Display and Control Panel
- Power Supply Panel
- Power Amplifier Panel
- Motor Panel

These units are described individually in the following sections, whilst the general appearance of the synchronizing equipment and the modified recorder is seen in Fig. 8.

### 6. Filter Panel

This panel, the circuit diagram of which is shown in Fig. 2, contains the 50 c/s rejectors for the programme circuits, the 50 c/s reference signal generator and combining network, the 50 c/s acceptor and the peak programme meter.

The two 50 c/s rejectors are identical in construction and each produces an attenuation of 40 dB at 50 c/s but only 1 dB at 100 c/s.

During recording the incoming programme is passed through 50 c/s rejector No. 1, combined with the 50 c/s reference tone and the composite signal fed into the recorder. Adjustment is provided so that the 50 c/s reference tone can be set to the normal operating level of 20 dB below peak modulation and a filter is incorporated to eliminate any harmonics which are present in the mains supply.

During replay the programme from the recorder is

passed through 50 c/s rejector No. 2 to eliminate the reference signal and is then available for monitoring and re-recording.

The reference signal is selected by a 50 c/s acceptor, which is bridged across the programme line from the recorder and fed to the input of the limiting amplifier on the Display and Control Panel.

The peak programme meter is switched by means of a relay to read the programme input to the panel during recording and the programme output from the panel during replay. This relay is operated by a d.c. supply derived from the tape recorder when the 'record' button is pressed.

The input of the peak programme meter and the input and outputs of both the filters are available on jacks for test purposes.

### 7. Display and Control Panel

#### 7.1 General

The circuit diagram of this panel is shown in Fig. 3.

The panel incorporates the main single-phase and three-phase supply switches, the limiting amplifier, the error indication and alarm circuits and the controls for alternative automatic or manual operation.

The reference signal derived from the 50 c/s acceptor on the Filter Panel is fed to the input of the limiting amplifier through a step-up transformer with a ratio of approximately 20:1.

In the limiting amplifier an H.F. pentode, type EF37A, is used as a first stage amplifier followed by a type 6J5 triode paraphase stage driving a push-pull output stage composed of two type 6V6 pentodes. A high-resistance is



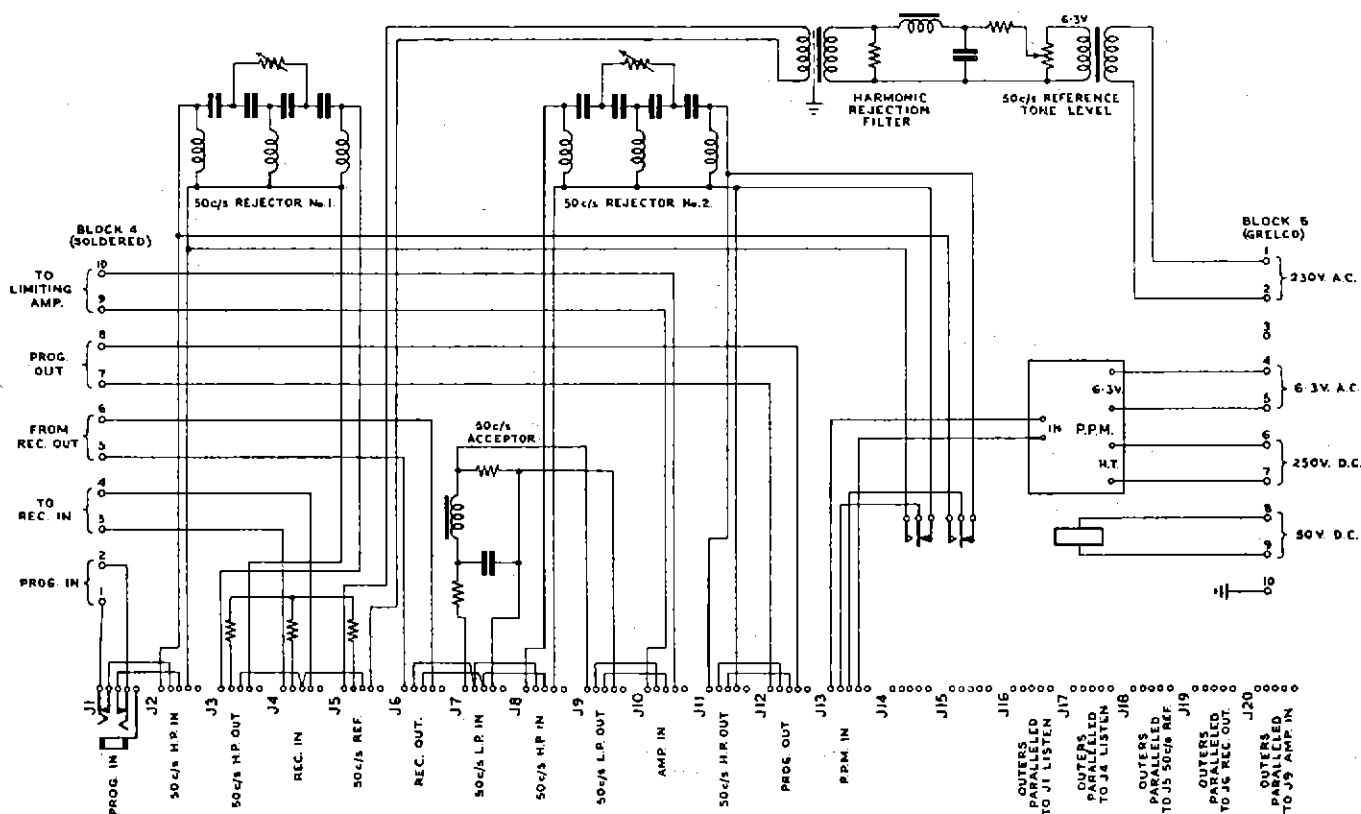


Fig. 2 — Filter panel—circuit diagram

included in the grid circuit of each 6V6 to limit the drive to the value at which grid current is taken and the output transformer and load are tuned to 50 c/s by a capacitor. This ensures that an approximately sinusoidal output is obtained whose amplitude and waveform remain virtually constant over a wide range of input levels.

The output of the limiting amplifier is fed to the tape error indicator magslip, to the input of the alarm amplifier, and, through the manual/automatic correction key, to the Power Amplifier Panel.

### 7.2 Tape Error Indication

Indication of tape error is provided by a magslip receiver which has 50V three-phase derived from the mains supply applied to its stator and the output of the limiting amplifier applied to its rotor, the latter having been re-wound for convenience in impedance matching.

The position of the magslip pointer gives a direct indication of the relative phase of the limiting amplifier output. The pointer is set to read zero tape error when the phase is that which produces the 90° equilibrium position of the corrector motor, as described in Part II Section 10.

### 7.3 Alarm Amplifier

The output of the limiting amplifier corresponding to zero tape error is balanced by a signal of equal amplitude and opposite phase derived from the mains supply by

means of a transmitter magslip and a step-up transformer having a ratio of approximately 14:1.

The amplitude is adjusted by the balance potentiometer and the phase is adjusted by turning the rotor of the transmitter magslip.

If a significant tape error occurs the phase of the output from the limiting amplifier changes and upsets the balance condition. The resulting signal is applied to the grid of a type 6J5 triode, which is biased almost to cut off, thus causing it to pass anode current and operate a relay. This relay operates a buzzer which is supplied with 30V a.c. from the motor panel.

An anode current meter is provided to facilitate setting up the equipment. The bias control is adjusted so that the 6J5 triode is almost cut off when the tape recorder is not running.

A previously recorded tape is then replayed and the balance control and transmitter magslip are adjusted for balance as indicated on the meter. The bias control is finally adjusted so that the buzzer sounds when the tape error exceeds 0.125 frame.

### 7.4 Manual/Automatic Correction

A key is incorporated by means of which the equipment may be operated with either automatic or manual correction.

The input to the Power Amplifier Panel is switched

either to an attenuated output from the limiting amplifier for automatic correction or to the rotor of a transmitter magslip for manual correction. Since the magslip stator is connected to a three-phase supply, the phase of the output from the rotor can be varied by rotating it to simulate a tape error of any magnitude. This facility is mainly useful for test purposes when checking the operation of the power amplifier and correction motor.

A switch in the stator circuit of the magslip connects it either to a three-phase supply derived directly from the mains or to a three-phase supply derived from the output of the selsyn differential as described in Part II Section 10.

In the first case a simulated tape error will produce con-

tinuous rotation of the correction motor. In the second case the correction motor will rotate only so far as is necessary to correct the error. This facility is useful in checking the time taken to correct errors of various magnitudes and in assessing the overall performance of the correction system.

## 8. Power Supply Panel

The circuit of this panel is shown in Fig. 4. It supplies 250V d.c. and 6.3V a.c. for the Display and Control Panel and the peak programme meter. A 500 ohm variable resistance is included for adjusting the 250V d.c. supply.

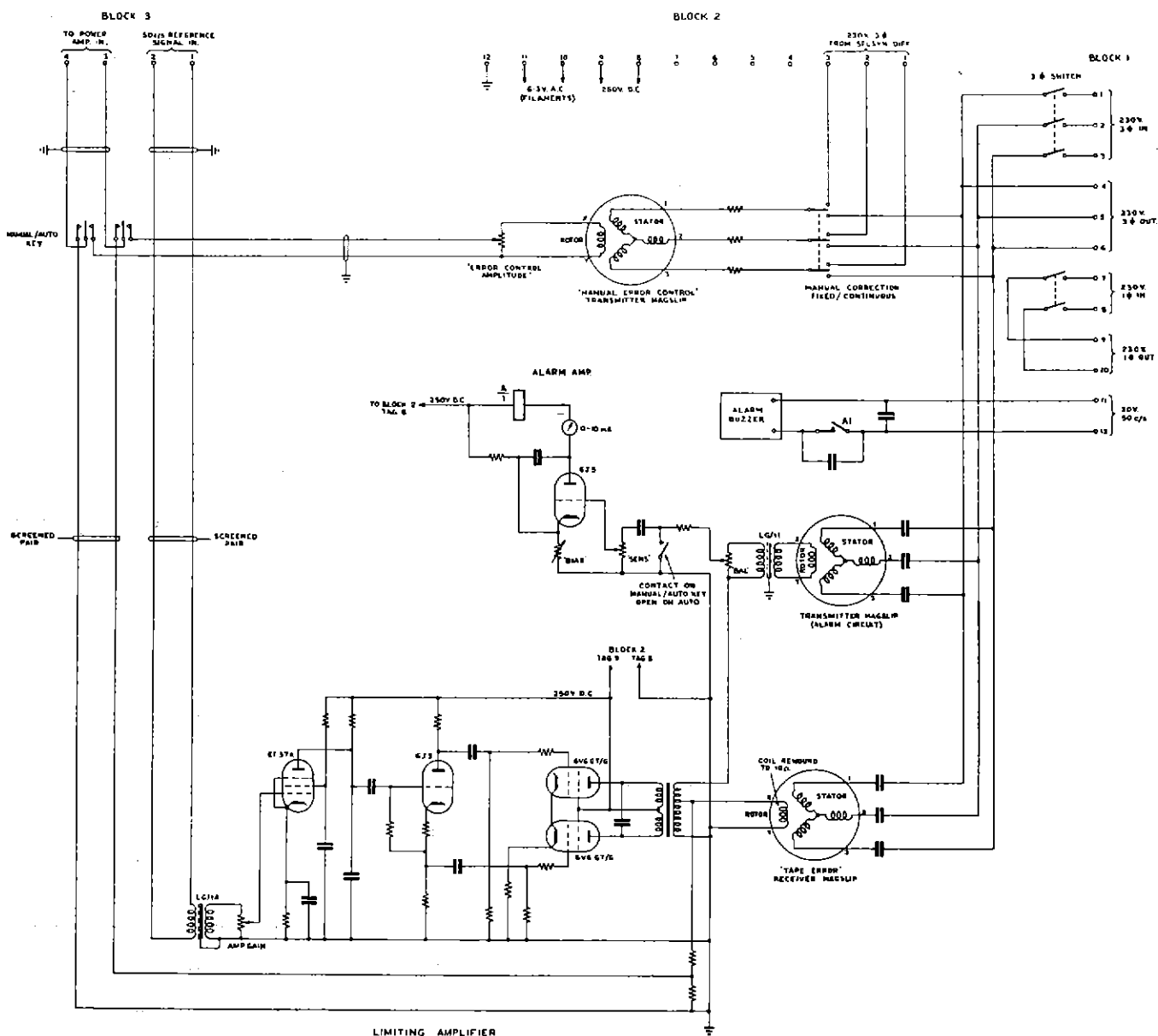


Fig. 3 — Display and control panel—circuit diagram



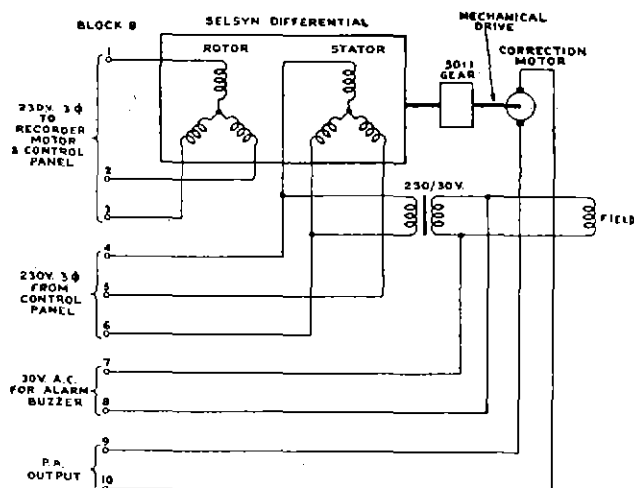


Fig. 6 — Motor panel—circuit diagram

reference signal to the armature windings and 30V 50 c/s, derived from the a.c. supply, to the field.

During normal operation the field and armature currents have substantially the same frequency but differ in phase and amplitude. It can be shown that if the phase difference between the two currents is  $\phi$ , the mean torque over one cycle is proportional to  $\cos \phi$ .

The torque is therefore positive and maximum when  $\phi=0^\circ$ , negative and maximum when  $\phi=180^\circ$ , and zero when  $\phi=90^\circ$  or  $270^\circ$ . There are therefore two equilibrium conditions; only one of these, however, is stable.

If it is assumed that the overall operation of the correction system is so arranged that when the torque is positive the rotation produced tends to increase  $\phi$ , then the equilibrium condition when  $\phi=90^\circ$  is stable, since if  $\phi$  falls below this value the torque is positive and if  $\phi$  increases above this value the torque is negative.

By similar reasoning it will be seen that the equilibrium condition when  $\phi=270^\circ$  is unstable.

The conditions for greatest torque, when  $\phi=0^\circ$  or  $180^\circ$ , correspond to a tape error of  $\pm 0.125$  frame.

This correction motor is mechanically coupled to a standard type of selsyn motor which is used as a continuously variable phase shifting transformer. 230V three-phase is applied to the stator and 230V three-phase is taken from the rotor windings, the phase of this output being varied as required by rotating the motor shaft.

Since the capstan motor runs synchronously from this supply, the effect of rotating the selsyn motor shaft is to advance or retard the tape.

In this way the drive from the correction motor is transmitted to the tape during replay and synchronism is maintained.

## 11. Modifications to the Tape Recorder

Provision is made for operating the BTR/1B recorder either separately or in conjunction with the synchronizing equipment.

The circuit arrangements provided to achieve these alternative methods of operation are shown in Fig. 7.

A change-over switch is incorporated which connects the synchronous capstan motor either to terminals 1 and 5, which is the normal condition, or to the automatic synchronizing equipment. A relay circuit is connected across terminals 1 and 5, which operates when the 'record' or 'replay' button is depressed. The relay contacts complete the circuit from the synchronizing equipment to the capstan motor.

A transformer and rectifier are connected across terminals 123 and 124, which carry the a.c. supply to the erase unit during recording.

The rectifier provides 50V d.c. for operating the relays in the synchronizing equipment.

The inclusion of these additional items in the recorder facilitates operation of the equipment as a whole since all operations are effected by the recorder controls in the normal way whether the recorder is used independently or in conjunction with the synchronizing equipment.

## 12. Conclusions

The equipment has proved satisfactory both on test and during operational service.

No difficulty has been experienced in maintaining synchronism, the amount of tape slippage being always well below the maximum which the equipment is designed to correct.

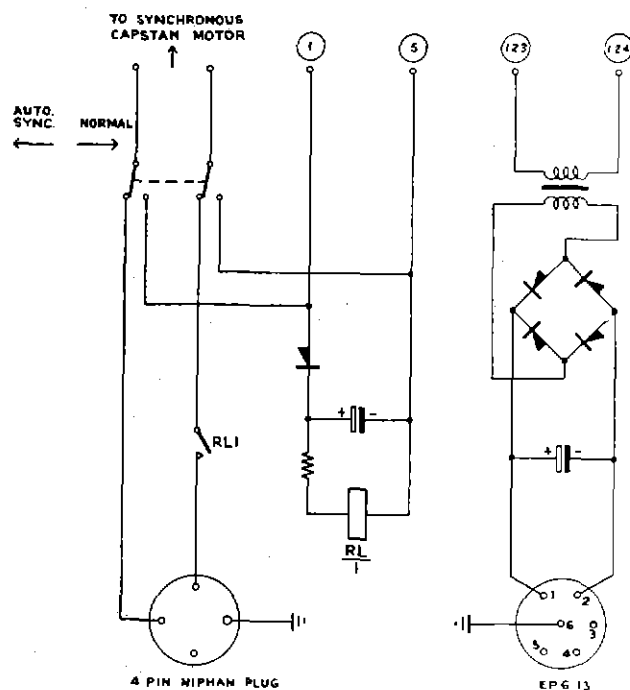


Fig. 7 — Diagram of modifications to BTR/1B recorder

During replay the indicated tape error seldom exceeds 0.05 frame. Maximum correction would occur when the error approached 0.125 frame, a condition which has not been encountered during normal operation. This represents virtually complete synchronism since on normal projection it is difficult to detect an error of one frame.

Since the error is never large the 'wow' introduced by the correction process is also kept at a negligible level and cannot be detected by normal listening tests.

In the present system the reference signal is combined with the recorded programme and 50 c/s rejectors are in-

cluded in the programme chain for the reasons discussed in Part I Sections 4.1 and 4.2.

The overall effect of these rejectors is virtually equivalent to inserting an 80 c/s high-pass filter in the programme circuit. Some loss of bass occurs but this has not been found to be a serious disadvantage in practice.

The difficulty could be overcome by recording the reference signal as the modulation envelope of a carrier of approximately 12 kc/s or by recording it on a separate track on the tape. Either course would, however, involve additional circuit complications which were not felt to be justified in the present equipment.

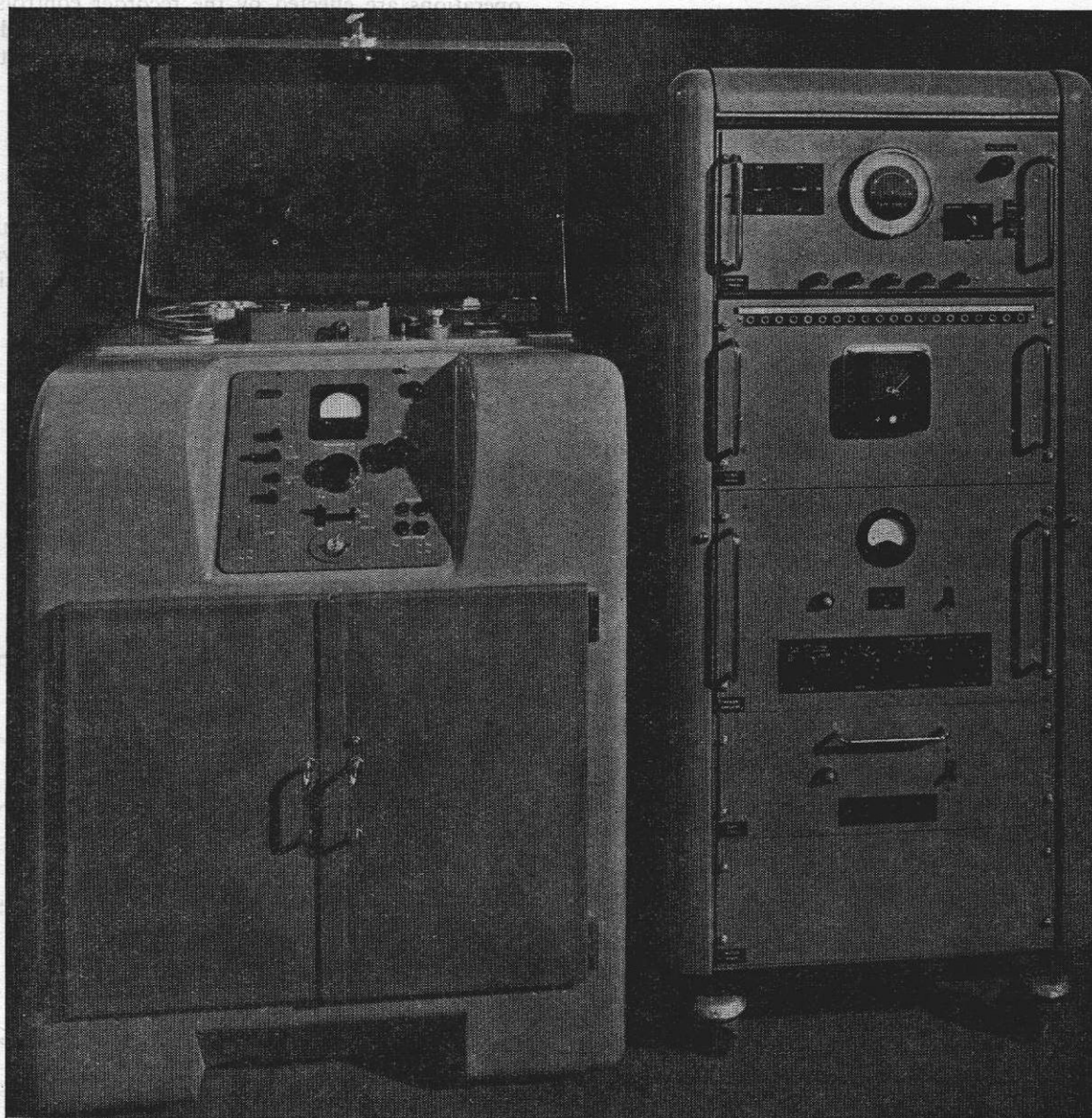


Fig. 8 — A general view of the complete equipment

## SOME RECENT BBC DEVELOPMENTS

### THE PROVISION OF HALF-STEPS OF ATTENUATION ON MULTI-WIPER VARIABLE ATTENUATORS AND FADERS

by

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The control of level of sound, television, and other signals is generally carried out by variable attenuators in balanced or unbalanced circuits. These attenuators are usually of the stud variety in which the attenuation is increased in discrete steps, and they are frequently of the constant impedance type. In order to attain these constant impedance characteristics, it is generally necessary to have at least two variable elements, one in the series arm of the network and one in the shunt arm, and this in turn necessitates two wiper assemblies.

In order to achieve the appropriate attenuation both these wipers must contact their relevant studs simultaneously, but when the attenuator is used for constantly varying the circuit attenuation, as in fading, it is inevitable that conditions will occur when one wiper is temporarily 'out of phase' as it were with its companion due to normal manufacturing tolerances. Since such a condition is bound to occur it would seem logical to make use of the fact deliberately.

In the majority of cases the attenuation in this out of phase condition is approximately the mean between the attenuations of the adjacent nominal stud positions, and if the angle of rotation corresponding to this condition were made equal to one-half of that corresponding to the full movement between adjacent studs then the number of usable discrete steps on the attenuator would be doubled. It does, of course, follow that the input and output impedances of the attenuator will vary from the nominal in the out of phase condition; however, this variation is not only generally small but, as already mentioned, occurs to some degree in all practical cases due to mechanical tolerances in manufacture.

The achievement of evenly spaced 'half' steps of attenuation in this way is not a matter of staggering the wiper arms by half the stud

spacing as might be at first thought. This is because the increase of attenuation involves the *increase* of the series arm resistance and the *decrease* of the shunt arm resistance. The former occurs when the series wiper *leaves* the previous stud while the latter happens when the shunt wiper *meets* the succeeding stud. Thus a normally constructed variable attenuator does already provide 'half' steps of attenuation, the proper positioning of the attenuation changes depending on the wiper width ( $w$ ), the stud diameter ( $d$ ), and the distance between adjacent stud faces ( $s$ ). It can be shown that for equal angular movements for each half-step of attenuation the following relationship must hold, assuming that the wipers are exactly centred on the studs in the normal position,

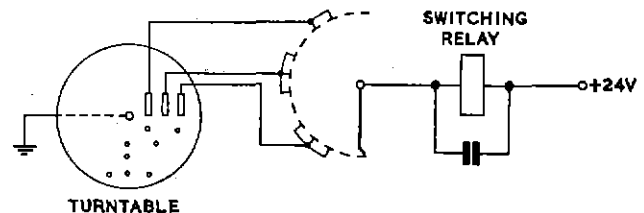
$$2w = 3s + d$$

### AUTOMATIC TIME SWITCH

This is a brief description of apparatus devised to provide switching operations at pre-determined times and for pre-determined periods. Corporation use is at present being made of this in order to record automatically periods of programme material.

Switching relays are connected to wipers of a uniselector driven by pulses from a clock circuit. When this uniselector completes one cycle it applies a pulse to an impulse motor driving an earthed metal turntable. This is faced with a disc of thin insulating material in which holes can be punched to allow fixed wiper contacts to earth to the turntable. Suitable wiring from the fixed wipers to the uniselector, sets the sequence and timing of the switching operations.

A simple circuit is shown below.



## Summaries of some recent BBC Patent Applications

PAT. APP. NO. 242/55

### TELEVISION SIGNAL BANDWIDTH COMPRESSION

**Inventor: G. G. GOURIET**

*The statement of invention reads:*

According to the present invention in one aspect there is provided a method of generating a television signal comprising generating one or two series of pulses at irregular time intervals, these pulses defining characteristics of a picture, namely the brightness levels and the durations of such levels, within predetermined limits, along a scanning path of a picture, and generating from the said one or two series of pulses one or two derived series of pulses at uniform time intervals and modulated in accordance with the said characteristics.

The invention protected is a method of generating a television signal with the object of economizing in the bandwidth required to transmit it.

PAT. APP. NO. 7273/55

### QUANTISING A COMPLEX WAVEFORM

**Inventor: E. R. ROUT**

*The statement of invention reads:*

According to the present invention main input terminals to which signals to be quantised are applied, are coupled to main output terminals through a gating device, and there are provided means for maintaining the signal amplitude at the output terminals substantially constant during times when the gating device is closed, a differentially responsive device having two input terminals coupled to the main input and output terminals respectively and adapted to produce an output in dependence upon the difference between the signal amplitudes at its two input terminals, and means adapted to generate and apply a pulse to the gating device, to open the device, when the said difference exceeds a predetermined value.

The invention is of particular application to modern communication theory, by means of which the information represented by a complex waveform may be transmitted in a greatly reduced bandwidth.

PAT. APP. NO. 7274/55

### BALANCED GATING CIRCUIT

**Inventor: W. SILVIE**

*The statement of invention reads:*

According to the present invention, a gating circuit comprises two valves each having a cathode, an anode, and a control grid, the cathodes being connected through a common cathode impedance to a negative source terminal, connections between the anodes and the positive source terminal, one of these connections containing an output impedance, a connection from that one of the two anodes which is connected to the output impedance to an output terminal and through a further impedance to the cathodes, a circuit coupling first and second input terminals, to which, in use, the switching signals and the signals to be gated are applied respectively, to the two control grids in such a manner that the two signals are applied to both grids, and means for reducing the effective value of the cathode impedance when the cathode potential falls below or rises

above a predetermined value, the arrangement being such that the circuit remains balanced with respect to signals applied to the second input terminal when the said impedance reducing means are inoperative and becomes unbalanced with respect to signals at this terminal when the said means are operative.

The invention is an improved gating circuit, in which the presence of the switching signal in the output is avoided without the necessity of additional circuitry.

PAT. APP. NO. 17462/55

### SYNCHRONIZATION OF SUBCARRIER REFERENCE OSCILLATOR

**Inventors: A. V. LORD, R. D. A. MAURICE, and R. F. VIGURS**

*The statement of invention reads:*

According to the present invention there is provided a receiver for use in a system of the kind specified in which the frequency of the oscillation generator is controlled by a reactance modulator, and in which the reactance of this modulator is controlled by two control voltages from a phase discriminator and a frequency discriminator respectively, the phase discriminator being arranged to generate its control voltage in dependence upon the phase difference between the received bursts of oscillation and the output of the said oscillation generator, and the frequency discriminator being arranged to generate its control voltage in dependence upon variations in the frequency of a received oscillation, or derived from one or more received oscillations, this frequency being fixedly related to the frequency of the carrier component of the received bursts of oscillation. The said received or derived oscillation preferably has a frequency bearing a simple fractional relation, such for example as  $\frac{4}{3}$ , to the frequency of the said carrier.

The invention relates to receivers for N.T.S.C.-type television systems, and is an improved arrangement for the synchronization of the receiver subcarrier reference oscillator, whose output must be identical in frequency with the transmitted subcarrier signal, and in constant phase relationship to it.

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### TELEVISION SYNCHRONIZING REGENERATION UNIT

**Inventors: S. N. WATSON and L. HOLT**

*The statement of invention reads:*

According to the present invention, a television receiver comprises a flywheel pulse generator adapted to be driven by received line synchronizing pulses and to generate correcting pulses substantially unaffected by noise accompanying received signals and having leading edges occurring a short time before the leading edges of the received synchronizing pulses, means for applying the correcting pulses to clamp the received signal at a suitable voltage level during the said short time, and means for applying the correcting pulses delayed by the said short time to introduce synchronizing pulses to replace the received synchronizing pulses.

The invention relates to synchronization in television and is concerned with the removal of or substantial reduction in the effect of random noise upon synchronization.





